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(54) **Bumper and front rail assembly for vehicle**

(57) A bumper and front rail assembly includes first and second front rails (12) with a steel cross-member (42) extending therebetween. The steel cross-member (42) has a substantially U-shaped cross-section. A steel forward member (44) is secured to the cross-member (42) and spans the length thereof. The forward member (44) is configured to act as a spring for elastic deformation against the cross-member (42) in a low energy impact. First and second steel crush cans (66) are disposed in the cross-member (42) adjacent the first and second front rails (12), respectively. The crush cans (66) are configured for improved energy management.

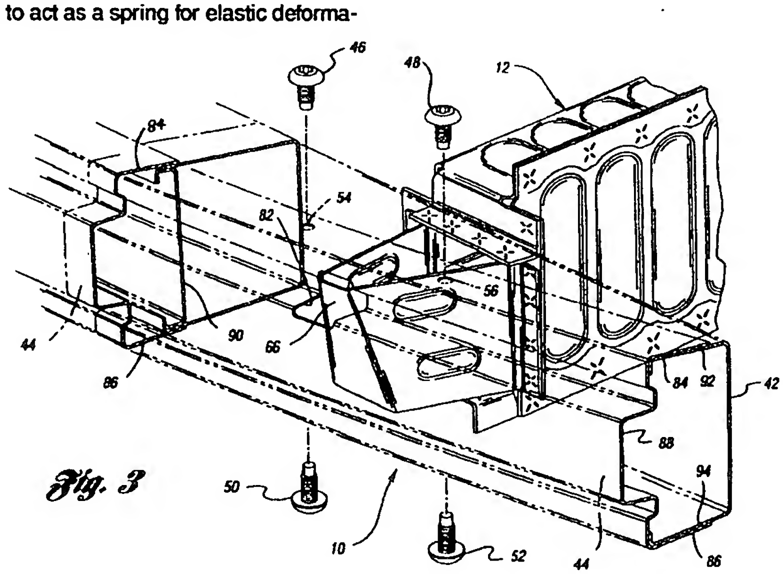

Fig. 3

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Description

The present invention relates to a bumper and front rail assembly for a vehicle including spring-steel dike components for improved energy management.

Typically, vehicl bumpers comprise a primarily plastic and/or steel construction designed for elastic deformation up to a 5 mile per hour impact. These bumpers are typically not of sufficient structural integrity to dissipate substantial energy in a high energy impact, i.e., an impact above 5 mph and up to 40 mph. Accordingly, since such bumper systems are typically 4-6 inches in depth, this 4-6 inches is wasted length which could be used for energy management. Also, such bumpers typically have insufficient structural integrity to generate a deceleration pulse significant enough to be sensed by a vehicle deceleration sensor for airbag deployment.

Another shortcoming of such bumpers is that offset frontal impacts create an energy pulse which is absorbed almost entirely in one of the front rails, and the energy management characteristics of the opposing front rail is not utilised.

Accordingly, it is desirable to provide a bumper and front rail assembly for a vehicle which deforms elastically in a low energy impact (less than 5 miles per hour), and absorbs a greater amount of energy in a high energy or high velocity impact in a manner sufficient to create a deceleration pulse which may be sensed for deployment of an airbag. It is further desirable to create a bumper and front rail assembly for a vehicle in which both front rails are used to dissipate energy in an offset frontal impact.

The present invention overcomes the above-referenced shortcomings of prior art vehicle bumper and front rail assemblies by providing a bumper assembly which comprises elongated engaging high strength steel members adapted for elastic deformation in a low energy impact, and further comprises crush cans disposed therebetween for increased energy dissipation in a high energy impact. One of the elongated steel members is welded at locations positioned along its length to the front rails for added torsional rigidity to distribute load between the front rails in an offset impact.

More specifically, the present invention provides a bumper and front rail assembly for a vehicle including first and second front rails and a steel cross-member extending therebetween. The steel cross-member has a substantially U-shaped cross-section. A steel forward member is secured to the cross-member and spans the length thereof. The forward member is configured to act as a spring for elastic deformation against the cross-member in a low energy impact. First and second steel crush cans are disposed in the cross-member adjacent the first and second front rails, respectively. The crush cans are configured for improved energy management.

Accordingly, an object of the present invention is to provide a bumper and front rail assembly for a vehicl including engaging elongated steel members configured for elastic deformation in a low energy impact, and also including crush cans secured therein and adapted for increased energy absorption in a high energy impact.

The inventi_n will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a partially phantom perspective view of a front rail and cross-member assembly in accordance with the present invention;

Figure 2 shows a partially phantom perspective view of a front rail, cross-member and crush can assembly in accordance with the embodiment shown in Figure 1;

Figure 3 shows a partially phantom perspective view of a bumper and front rail assembly in accordance with the present invention corresponding with the embodiment shown in Figures 1 and 2;

Figure 4 shows a schematic finite element analysis model side view of the bumper, cross-member and crush can assembly of Figure 3, taken along the centre line of the front rail;

Figure 5 shows a schematic finite element analysis model side view of a partially elastically deformed bumper, cross-member and crush can assembly in accordance with the embodiment shown in Figure 4 illustrating sequential deformation positions;

Figure 6 shows a schematic finite element analysis model side view of a fully elastically deformed bumper cross-member and crush can assembly in accordance with the structure shown in Figures 4 and 5 illustrating sequential deformation positions;

Figure 7 shows a partially phantom perspective view of a bumper and front rail assembly in accordance with an alternative embodiment of the present invention;

Figure 8 shows a partially phantom perspective view of a front rail, cross-member and reinforcement member assembly in accordance with the embodiment shown in Figure 7;

Figure 9 shows a partially phantom perspective view of a front rail, cross-member and crush can assembly in accordance with the embodiment shown in Figures 7 and 8; and

Figure 10 shows a partially phantom partially cutaway perspective view of a bumper and front rail assembly in accordance with the embodiment shown in Figures 7-9.

Referring to Figures 1-3, a bumper and front rail assembly 10 is shown in accordance with a first embodiment of the present invention. The bumper and front rail assembly 10 includes first and second front rails 12 (only one such rail is shown in Figures 1-3). Th front rails 12 each include a plurality of convolutions 14,16 formed thereon to encourage natural and substantially

sequential deformation of the rail 12 in a high energy impact. Each front rail 12 includes mating high strength steel components 18,20 having flanges 22, 24, 26, 28 extending therefrom to facilitate welding of the rail components 18,20 together at the weld locations 30,32, shown in Figure 1.

The front rails 12 also include forward flanges 34, 36, 38, 40 which are adapted for welding to the steel cross-member 42 which extends between the first and second front rails 12 and comprises a substantially U-shaped cross-section. By welding the cross-member 42 to the front rails 12 at a plurality of locations 17 and 19 arranged longitudinally with respect to the cross-member, torsional rigidity is improved at the joint between the steel cross-member and the respective side rail such that energy from an offset frontal impact is more evenly distributed between the opposing front rails for energy management and dissipation.

Turning to Figure 3, the bumper and front rail assembly 10 also includes a steel forward member 44 secured to the cross-member 42 and spanning the length thereof. The forward member 44 is configured to act as a spring for elastic deformation against the cross-member 42 in a low energy impact. The forward member 44 is secured to the cross-member 42 by the screws 46, 48, 50, 52 which extend through apertures 54,56, which are positioned along the cross-member 42 closely adjacent the respective front rail, and engage the threaded nuts 58, 60, 62, 64. In this configuration, substantial elastic flexing of the forward member 44 is allowed with respect to the cross-member 42 in a low energy impact.

As shown in Figure 3, the bumper and front rail assembly 10 further comprises a steel reinforcement member 90 extending within the cross-member 42. The reinforcement member 90 and cross-member 42 cooperate to form a substantially rectangular cross-section for improved structural integrity.

The bumper and front rail assembly 10 further includes a crush can 66 disposed within the cross-member 42 immediately adjacent each front rail. The crush can 66 includes opposing flanges 68,70 extending therefrom to be welded to the rear of the cross-member 42 at the weld locations 72, as shown in Figure 2. The crush cans 66 comprise high strength steel having tapered opposing walls 74,76 which extend to the opposing flanges 68,70, respectively. The opposing walls 74,76 have elongated bumps 78,80 formed thereon for added structural integrity. These crush cans 66 are configured for slight elastic deformation in a low energy impact, and are further configured for added structural integrity in a high energy impact. The reinforcement member 90 discussed above extends between the crush cans 66.

As shown in Figure 3, an aperture 82 is formed in the forward member 44 so that crush can 66 does not interfere therewith in a low energy impact. In a low energy impact, the outer flanges 84,86 extend outwardly away from the cross-member 42 as the centre portion 88 is deflected inward. This elastic deformation is illustrated sequentially in Figures 4-6. As shown, th centre portion 88 is compressed into the cross-member 42 as the outer flanges 84,86 of the forward member 44 expand outwardly. The centre portion 88 continues to deform into the cross-member 42 until the crush can 66 engages the forward peripheral edge of the aperture 82 in the forward member 44 such that the crush can 66 also begins to deform elastically, and the reinforcement member 90 also begins to bend elastically as a result of the slight separation of the opposing sides 92,94 of the cross-member 42. Deformation beyond this elastic point then becomes inelastic and the crush cans are operative to dissipate substantial energy in a high energy impact.

Turning to Figures 7-9, an alternative embodiment of the present invention is shown. As shown in Figure 7, this embodiment also comprises first and second front rails 98,100 having a cross-member 102 extending therebetween. This embodiment further comprises a forward member 104 secured by screws 106, 108, 110, 112 to the cross-member 102. A front plate 114 is welded to the forward member 104 to prevent buckling during certain frontal impacts. This embodiment also includes a centre reinforcement 116 secured within the forward member 104 and having curves 118,120 formed therealong for added structural integrity. The forward member 102 is welded to the front rails 98,100 in the same manner as described above with reference to the embodiment shown in Figures 1-3. The reinforcement 116 is also welded to the cross-member 102.

In this embodiment, the forward member 104 includes opposing flanges 122,124 which are disposed within the opposing sides 126,128 of the cross-member 102 so that the opposing flanges 122,124 are elastically deformed inwardly with respect to the opposing sides 126,128 of the cross-member 102 in a low energy impact situation. The opposing flanges 122,124 include inwardly projecting portions 130,132, shown in Figure 10, to encourage such inward elastic deformation.

This embodiment also includes opposing crush cans 134 for further energy management.

Accordingly, in the above-described embodiments, low energy elastic deformation is achieved, as well as providing a front-loaded pulse for higher energy impacts which is operative to deploy an airbag and to begin substantial energy dissipation in the bumper area. These embodiments also provide more even loading of the opposing front rails in a frontal offset impact. To date, no such bumper and front system has been provided with such diverse energy management characteristics.

Each structural component comprises a high strength stamped steel which allows spring action in a 5 mile per hour impact. This spring action absorbs impact energy of the vehicle by allowing the forward member to deflect into th reinforcement and then both distort as a unit w ll within the elastic rang of the material. Both

parts are stressed on all surfaces relatively uniformly, thereby preventing localised high stress areas and permanent set. The shapes of the cross-member, reinforcement, and forward member affect energy management and impact response to prevent front fascia damage. The forward member tends to become straight because of the plan view sweep which grows in width, causing the forward member to load the crush cans. The stiffness of the vehicle front rails is set to yield above the yield point of the bumper system so there is no damage in a low energy impact.

Claims

1. A bumper assembly for attachment to the front rails (12) of a vehicle, comprising:

    a steel cross-member (42) adapted for attachment to the front rails (12) for extending thereacross, and having a substantially U-shaped cross-section;
    a steel forward member (44) secured to said cross-member (42) and spanning the length thereof, said forward member (44) being configured to act as a spring for elastic deformation against said cross-member (42) in a low-energy impact; and
    first and second steel crush cans (66) disposed in said cross-member (42) adjacent said first and second front rails (12), respectively, said crush cans (66) being configured for improved energy management.

2. A bumper assembly as claimed in claim 1, further comprising a steel reinforcement member (90) extending within said cross-member (42) between said crush cans (66), said reinforcement member (90) and said cross-member (42) cooperating to form a substantially rectangular cross-section for improved structural integrity.

3. A bumper assembly as claimed in either claim 1 or claim 2, wherein said forward member (44) is secured to the cross-member (42) only at locations near said crush cans (66) to permit a greater degree of said elastic deformation between the crush cans (66).

4. A bumper assembly as claimed in any one of claims 1 to 3, wherein said forward member (44) comprises an aperture (82) formed therein corresponding with each said crush can (66) such that the crush cans protrude through the respective aperture (82) in a manner such that a clearance gap exists between the crush can (66) and the forward edge of the respective aperture to permit such elastic deformation.

5. A bumper assembly as claimed in any one of the preceding claims, wherein each said crush can (66) comprises opposing flanges (68,70) welded to th cross-member (42).

6. A bumper assembly as claimed in claim 5, wherein each said crush can (66) comprises opposing tapered walls (74,76) with elongated bumps (78,80) formed thereon to encourage natural deformation thereof.

7. A bumper assembly as claimed in any one of the preceding claims, wherein said forward member (44) comprises opposing outer flange portions (84,86) spanning the length thereof and configured to engage said cross-member (42) outside said substantially U-shaped cross-section such that said outer flange portions (84,86) deform outward away from the cross-member (42) in an elastic deformation situation.

8. A bumper assembly as claimed in claim 1, wherein said forward member (104) comprises opposing outer flange portions (122,124) spanning the length thereof and configured to engage said cross-member (102) inside said substantially U-shaped cross-section such that said outer flange portions (122,124) deform inward within the U-shaped cross-section in an elastic deformation situation.

9. A bumper assembly as claimed in any one of the preceding claims, wherein the cross-member (42), forward member (44) and crush cans (66) are configured to provide a deceleration pulse sufficient to deploy an airbag in a high energy frontal impact.

10. A bumper and front rail assembly for a vehicle, comprising:

    first and second front rails (12);
    a steel cross-member (42) extending between said first and second front rails (12) and having a substantially U-shaped cross-section;
    a steel forward member (44) secured to said cross-member (42) and spanning the length thereof, said forward member (44) being configured to act as a spring for elastic deformation against said cross-member (42) in a low-energy impact;
    first and second steel crush cans (66) disposed in said cross-member (42) adjacent said first and second front rails (12), respectively, said crush cans (66) being configured for improved energy absorption; and
    a steel reinforcement member (90) extending within the cross-member (42) between the crush cans (66), said reinforcement m mber (90) and said cross-member (42) co-operating

to form a substantially rectangular cross-section for improved structural integrity.

Fig. 1

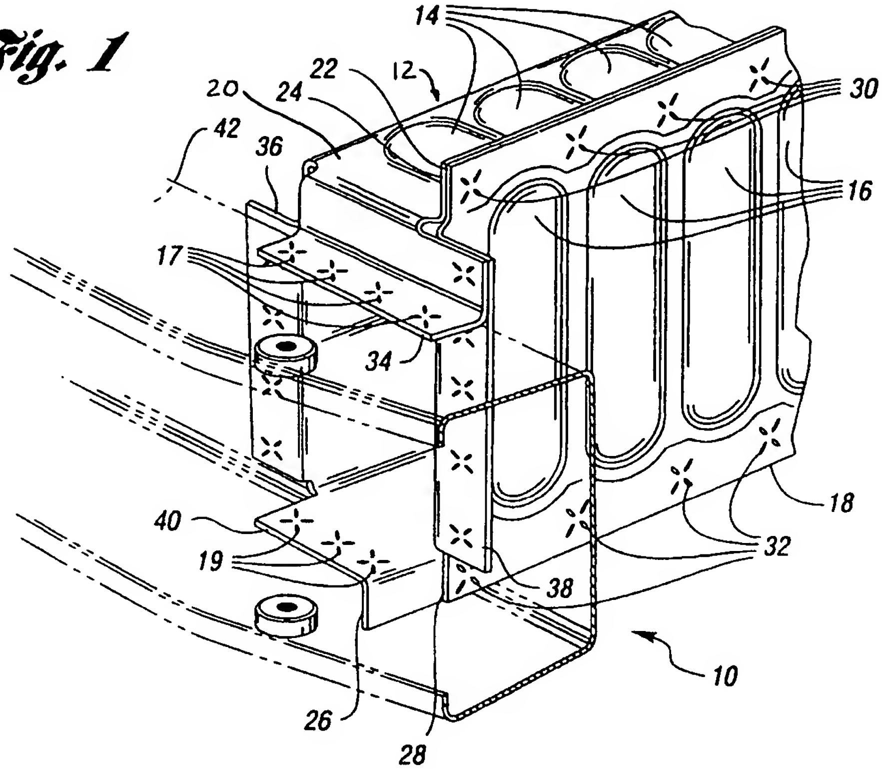
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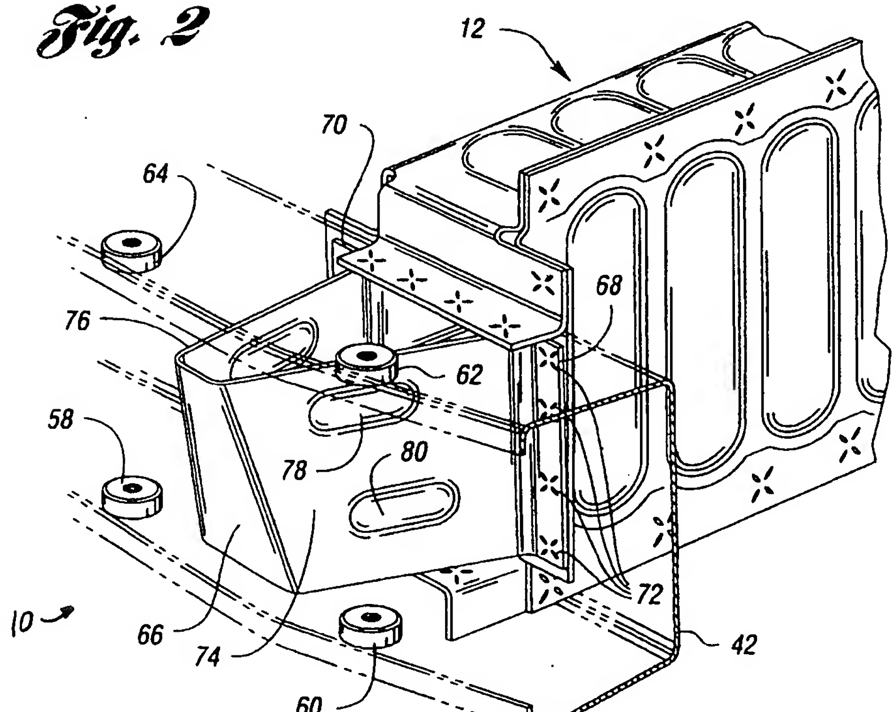
Fig. 2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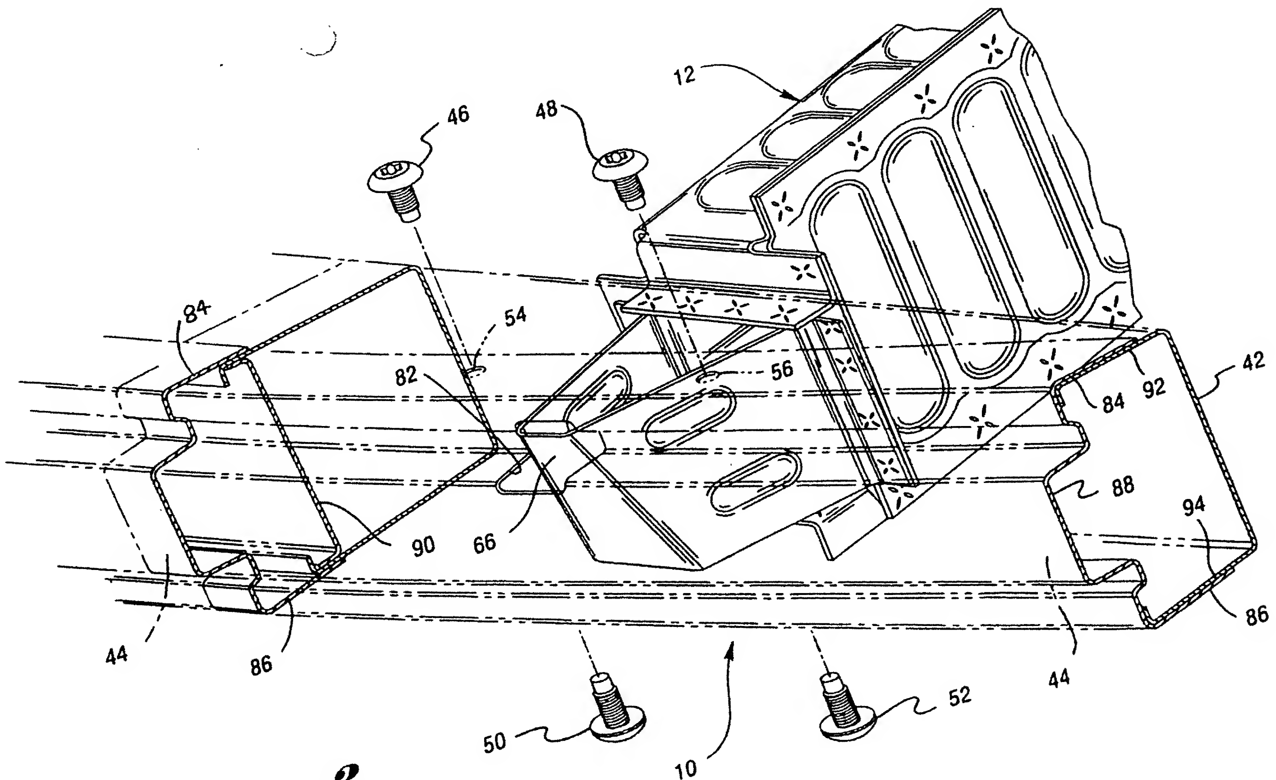


Fig. 3

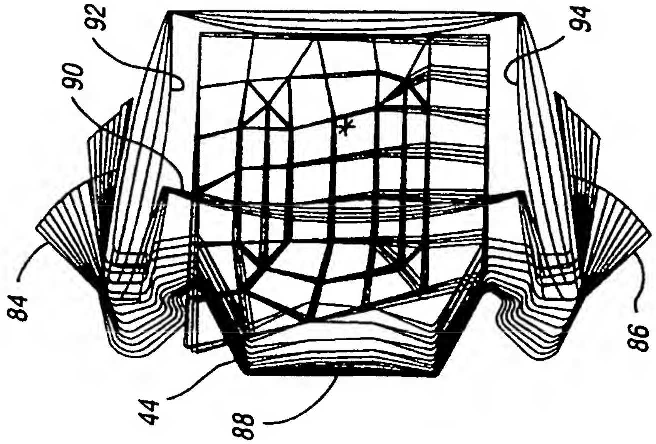


Fig. 6

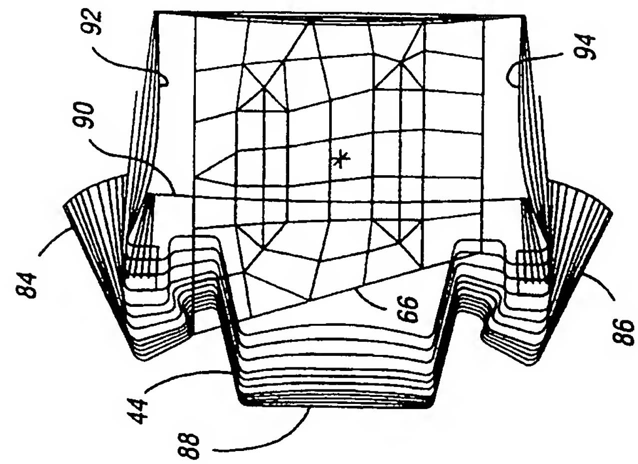


Fig. 5

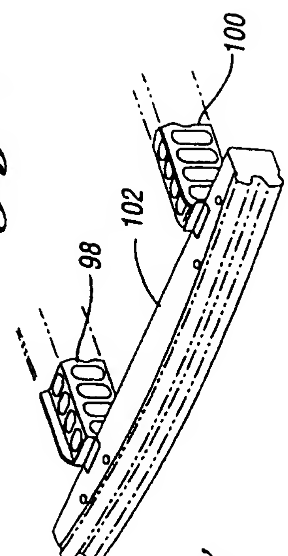


Fig. 7

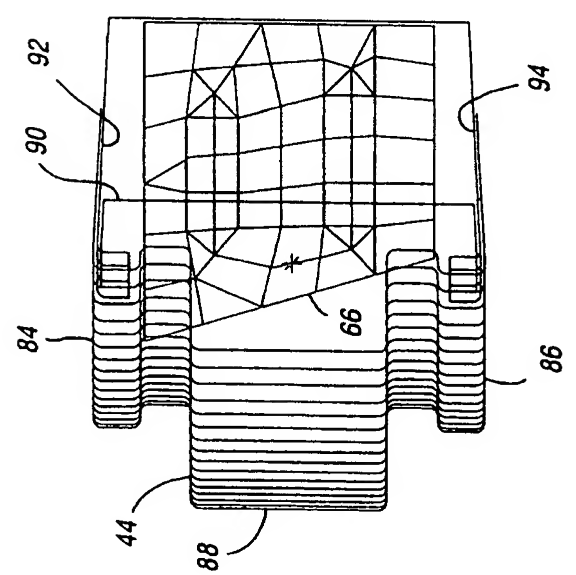


Fig. 4

Fig. 8

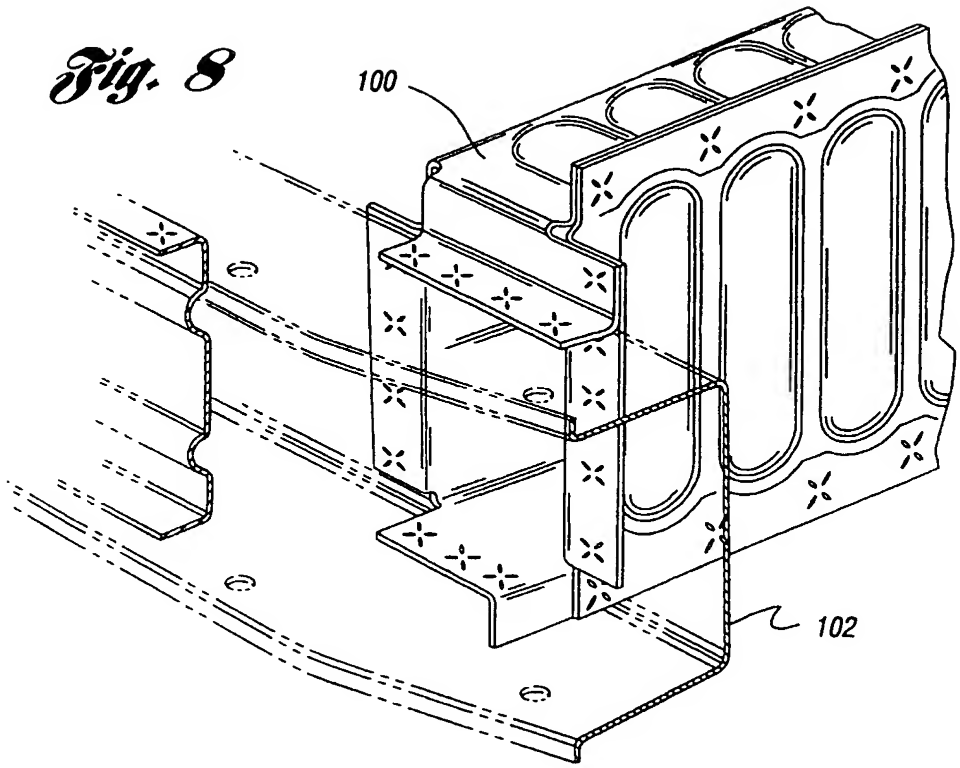
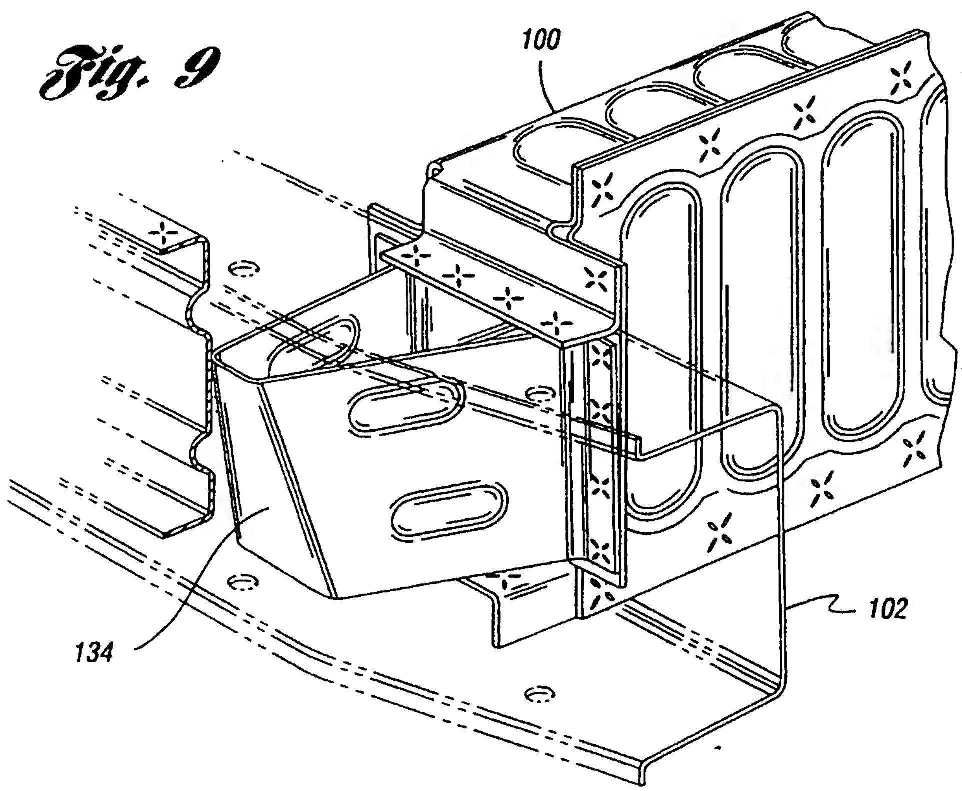


Fig. 9



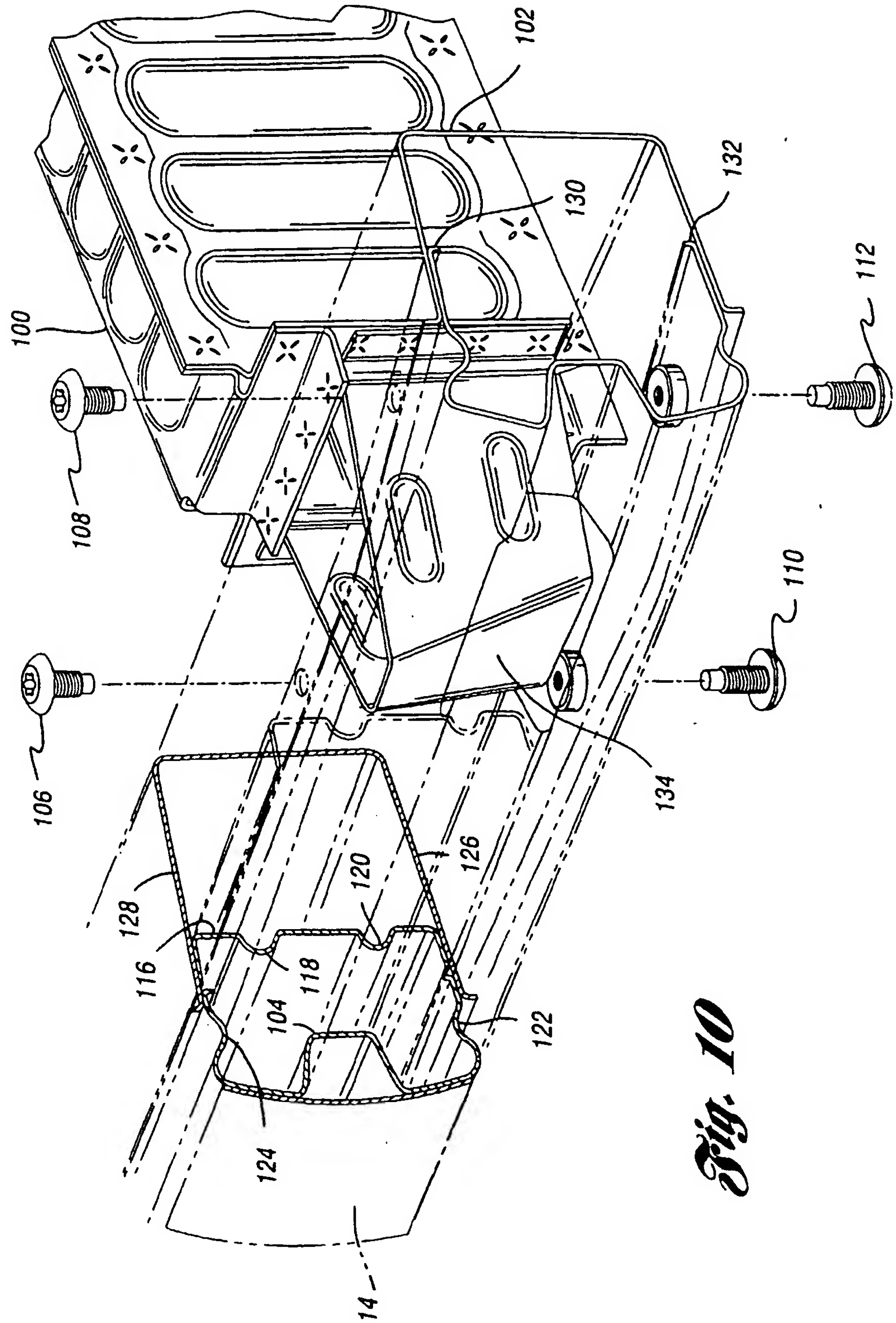

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Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 97 31 0735

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y A	JP 05 112 195 A (MAZDA MOTOR CORP) * column 6, line 9 - column 7, line 29; figures 3-5 * ---	1 10	B60R19/18
Y A	US 5 139 297 A (RONALD A.CARPENTER ET AL) * column 3, line 33 - column 4, line 30 * * column 5, line 39 - line 55; figures 1,2,5,6 * ---	1 10	
A	DE 43 07 836 A (VOLKSWAGEN AG.) * page 2, line 6 - line 43; figures 1,3,4 * ---	1,10	
A	US 5 385 375 A (TERRY B. MORGAN ET AL) * column 3, line 1 - line 18; figure 1 * ---	1,5,6,10	
A	EP 0 716 961 A (SOCIÉTÉ ANONYME DITE: RÉGIE NATIONALE DES USINES RENAULT) * column 3, line 1 - line 15; figure 1 * -----	1,10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B60R B62D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	23 April 1998	Deprun, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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